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An Evaluation of Japanese Elementary Students' Understanding of the Criteria for Rebuttals in Argumentation

Keita Muratsu[a,*], Shigenori Inagaki[b], Etsuji Yamaguchi[c], Tomokazu Yamamoto[d], Miki Sakamoto[e], Shinichi Kamiyama[f]

[a] *Research Fellow of Japan Society for the Promotion of Science, 5-3-1, Kojimachi, Chiyoda-ku, Tokyo, 102-0083, Japan*
[a, b, c, e, f] *Graduate School of Human Development and Environment, Kobe University, 3-11 Tsurukabuto Nada-ku, Kobe, 657-8501, Japan*
[d] *Faculty of Education and Culture, University of Miyazaki, 1-1 Gakuenkibanadai Nishi, Miyazaki, 889-2912, Japan*
[f] *Elementary School Attached to Kobe University, 3-4, Yamashitacho, Akashi-shi, Hyogo, 673-0878, Japan*

Abstract

Our purpose is to identify the Japanese six grade (aged 11-12 years) elementary school students' understanding of the criteria for quality of rebuttals before they learn on argumentation. The criteria for high-quality rebuttals include explicitly pointing out the errors in other people's statements (pointing out) and explaining reasons as to why the statements are incorrect (reasons). We conducted the evaluation task to identify students' understanding of the criteria for quality of rebuttals. The results revealed that many students recognized rebuttals include reasons as high-quality rebuttals, but did not recognize rebuttals include pointing out as high-quality rebuttals.

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1. Introduction

Argumentation is a process whereby several people discuss conflicting hypotheses (Kuhn & Franklin, 2006). In recent research on science education, studies focused on argumentation have been gaining attention (e.g., Erduran & Jiménez-Aleixandre, 2008). Osborne (2010) suggests that opportunities for students to engage in argumentation

* Corresponding author. Tel.: +81-90-6237-0729.
E-mail address: 115d101d@stu.kobe-u.ac.jp

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offer a way of enhancing students' conceptual understanding and students' capabilities with scientific reasoning and scientific rebuttals. And McDonald & Kelly (2012) says that argumentation is the authentic activity for scientists, so students should engage in this activity.

Science lessons on argumentation aim to enable students to state high-quality rebuttals to others (Osborne, Erduran, & Simon, 2004). The reason for doing so is that rebuttals can give students the opportunity to re-evaluate their ideas and generate more scientifically appropriate ideas. Hence, encouraging an understanding of the criteria regarding the quality of rebuttals is drawing attention as a teaching strategy to help students to state high-quality rebuttals (Osborne, Erduran, & Simon, 2004). The criteria for high-quality rebuttals include explicitly pointing out the errors in other people's statements and explaining reasons as to why the statements are incorrect (Erduran, Simon & Osborn, 2004; von Aufschnaiter, Erduran, Osborne, & Simon, 2008).

However, there are few studies on the understanding of students before they learn the criteria for high-quality rebuttals in argumentation. This indicates that the fundamental knowledge necessary to develop teaching strategies—for example, the type of misunderstandings that students have about the criteria for rebuttals—has not been sufficiently examined.

The purpose of this study is therefore to identify the students' understanding of the criteria for quality of rebuttals before they learn on argumentation. By giving special consideration to the study of Zembal-Saul et al. (2012), which proposes introduction the teaching of rebuttals from middle school onwards, we chose the sixth grade elementary school students, prior to the introduction of rebuttals, to be the subjects of this study.

2. Theoretical framework

Erduran et al. (2004) and von Aufschnaiter et al. (2008) divided rebuttals into two categories, clearly identifiable and weak, in their case study analyses of students' statements in argumentation. A clearly identifiable rebuttal is a high-quality rebuttal that is indispensable in argumentation, which students should thus state. The criteria for clearly identifiable rebuttals should include the following two elements.

In the first, students explicitly point out the errors in other people's statement (hereafter, 'pointing out'), while in the second, students explain the reasons why the statements pointed out are incorrect (hereafter, 'reason'). On the one hand, a weak rebuttal is a low-quality rebuttal with insufficient information to convince others. Its characteristics include a lack of pointing out the errors in others' statement or explaining the reasons why the statements are incorrect.

3. Research method

3.1. Research question

Our research question for this study is how do Japanese sixth grade elementary school students understand the criteria for the quality of rebuttals before they learn about argumentation.

We conducted the evaluation task as follows; first, the participants were given an argument included scientifically incorrect ideas. Next, three different rebuttals to the scientifically incorrect idea were presented to participants. Finally, participants were asked to provide answers that whether these three types of different rebuttals are a high quality or a low quality.

3.2. Task and procedure

The participants comprised 117 Japanese sixth grade elementary school students (aged 11-12 years). They had not received science lessons on argumentation prior to this study. The evaluation task consisted of three items. The item 1 was designed to investigate whether the participants understood that a clearly identifiable rebuttal, including pointing out and reasons, was high quality (hereafter, 'Rebuttal 1'). The item 2 aimed to examine whether they understood that a weak rebuttal, including pointing out but without reasons, was low quality (hereafter, 'Rebuttal 2'). Finally, the item 3 was designed to study whether they understood that a weak rebuttal, including reasons but without pointing out, was low quality (hereafter, 'Rebuttal 3'). The clearly identifiable and weak rebuttals included

in these items are based on Erduran et al. (2004).

First, the participants were given an argument on the topic of volume expansion in relation to the freezing of water (described as 'Ms. Hanako's argument' in this lesson). This argument included scientifically incorrect ideas. Next, three types of different rebuttals—Rebuttal 1, Rebuttal 2, and Rebuttal 3—to the scientifically incorrect idea of Ms. Hanako's argument on the topic of volume expansion in relation to the freezing of water were presented to participants. Participants were asked to provide answers for these three types of rebuttals based on two response categories: 'it is a high-quality rebuttal' or 'it is a low-quality rebuttal'. In addition, participants were asked to explain why they had chosen a particular category using a free description.

The evaluation task was given to all participants. It took approximately 15 minutes. The task was conducted on December 2013.

3.3. Analysis

In item 1, participants who identified the rebuttal to be high quality and explained in the free description that 'Rebuttal 1 includes both pointing out and reasons' were marked correctly. In item 2, participants who identified the rebuttal to be low quality and wrote that 'Rebuttal 2 does not include reasons' were marked correctly. Finally, in item 3, participants who identified the rebuttal to be low quality and explained that 'Rebuttal 3 does not include pointing out' were marked correctly.

4. Results

Table 1 below shows the distribution of the number of participants who provided a correct or incorrect answer for each item. As to item 1, the results showed that 41 participants answered correctly compared to 76 who answered incorrectly. To examine this difference in the distribution of participants' responses, we conducted Fisher's exact test. The results of the test revealed that the number of the participants giving an incorrect answer was significantly higher than those providing a correct answer ($p < .01$).

Table 1. Distribution of the number of participants with correct or incorrect answers for each item.

Item	Contents of item	Correct answer	Incorrect answer
(1)	Clearly identifiable rebuttals with both pointing out and reasons	41 (35%)	76 (65%)
(2)	Weak rebuttals with pointing out but without reasons	113 (97%)	4 (3%)
(3)	Weak rebuttals with reasons but without pointing out	37 (32%)	80 (68%)

Note. $N = 117$, The number indicate the number of participants.

Table 2 shows some typical examples of the free description answers of participants who gave a correct or incorrect answer for item 1. Participant 1, who answered correctly, explained in the free description section that Rebuttal 1 states that Ms. Hanako's argument is wrong, while also providing reasons using data. In this description, Participant 1 took into account both aspects of pointing out and reasons as required for high-quality rebuttals. On the other hand, Participant 2, who gave an incorrect answer, describes Rebuttal 1 as a low-quality rebuttal because it includes data, but not scientific principles. Participant 2 did not pay attention to the presence or absence of pointing out, and only focused on the number of reasons stated.

As to item 2, the vast majority of the 113 participants provided the correct answer. To examine the differences in the distribution of participants who answered correctly or incorrectly, we conducted Fisher's exact test. The results of the test revealed that the number of the participants answering correctly was significantly higher than those answering incorrectly ($p < .01$).

Table 3 below provides an example of a correct answer in the free description for item 2; as most participants answered correctly, no example is provided for an incorrect answer. Participant 3, who answered correctly, confirmed that Rebuttal 2 explains that Ms. Hanako's argument is wrong, but this is not enough as no reasons are

given as to why. Participant 3's response reflects an understanding that merely pointing out is insufficient and that reasons must be presented in high-quality rebuttals.

Table 2. Typical examples of descriptions given by participants providing a correct or incorrect answer for item 1.

Correct and incorrect answer for free description by Participant 1 and 2
P1 (correct): The rebuttal is complete because it first explains that the argument is 'wrong' and then describes the reasons why it is wrong using evidence.
P2 (incorrect): The rebuttal explains which part of Ms. Hanako's opinion is wrong using data but does not include scientific principles.

Note. P1: Participant 1, P2: Participant 2.

Table 3. A typical example of a description given by a participant providing a correct answer in item 2.

Correct answer for free description by Participant 3
P3 (correct): This rebuttal to the scientifically incorrect idea of Ms. Hanako's argument on the topic of volume expansion in relation to the freezing of water does not state the reasons why Ms. Hanako's opinion is wrong. It just says that it is wrong. So, I think Rebuttal 2 is not good rebuttal.

Note. P3: Participant 3.

Finally, in terms of item 3, only 37 participants gave a correct answer compared to 80 with an incorrect answer. To examine this difference, we conducted Fisher's exact test. The result of the test revealed that the number of participants who providing an incorrect answer was significantly higher than participants who providing a correct answer ($p < .01$).

Table 4 below shows some typical examples of the free description responses of participants who answered item 3 correctly or incorrectly. Participant 4, who gave a correct answer, stated that Rebuttal 3 explains why other people's statements are wrong using data, although it is unclear which part of their opinions is erroneous. Thus, participant 4 identified that Rebuttal 3 lacked the aspect of pointing out. On the other hand, Participant 5, who gave an incorrect answer, regarded Rebuttal 3 to be of high quality, even though it lacks pointing out, as the participant believed that Rebuttal 3 offered reasons using data and scientific principles. This means that the participant 5 made a misjudgement by viewing it as a high-quality rebuttal even though it only included reasons.

Taking into considerations of these results, we can speculate that many participants recognized rebuttals include reasons as high-quality rebuttals, but did not recognize rebuttals include pointing out as high-quality rebuttals.

Table 4. Typical examples of descriptions given by participants providing a correct or incorrect answer for item 3.

Correct answer for free description by Participant 4 and 5
P4 (correct): The rebuttal states reasons why Ms. Hanako's opinion is wrong using scientific principles, but it is unclear which part of her statement is wrong.
P5 (incorrect): This rebuttal provides experimental data and scientific principles, and thus clearly states the person's opinion.

Note. P4: Participant 4, P5: Participant 5.

5. Conclusions

In this study, we identified whether Japanese sixth grade elementary school students before they learn about argumentation could understand the criteria for the quality of rebuttals. The results revealed that many students recognized rebuttals include reasons as high-quality rebuttals, but did not recognize rebuttals include pointing out as high-quality rebuttals.

Our future work includes developing the teaching strategy focusing on rebuttal, especially that the high-quality rebuttal requires not only reason but also pointing out, and identifying the students' understanding of the criteria for quality of rebuttals before they learn on argumentation with more elementary students.

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